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(54) Title: POWER BRANCHING TRANSMISSION

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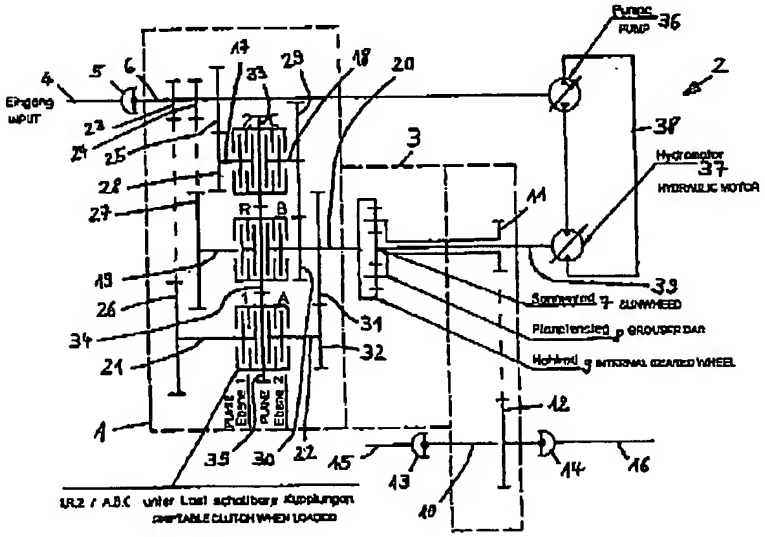

(57) Abstract: A power branching transmission which is especially used for tractors, wheel and chain driven working machines and commercial vehicles. In order to provide an advantageous transmission, said transmission possesses a mechanical branch (1), a hydrostatic branch (2) and one or more planetary gears (3), whereby the mechanical power fraction and hydrostatic power fraction are recombined.

(57) Zusammenfassung: Ein Leistungsverzweigungsgetriebe dient insbesondere für Traktoren, rad- und kettengetriebene Arbeitsmaschinen und Nutzkraftwagen. Um ein vorteilhaftes Leistungsverzweigungsgetriebe zu schaffen, besitzt dieses einen mechanischen Zweig (1), einen hydrostatischen Zweig (2) und ein oder mehrere Planetengetriebe (3), durch das der mechanische Leistungsanteil und der hydrostatische Leistungsanteil wieder zusammengeführt werden.

WO 00/71377 A1

CA 02383121 2001-11-21

WO 00/71377 A1

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— *Mit internationalem Recherchenbericht.*

— *Vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eintreffen.*

Zur Erklärung der Zweibuchstaben-Codes, und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

POWER BRANCHING TRANSMISSION

The invention concerns a power branching transmission, especially for tractors, wheeled and tracked working machines and commercial vehicles. This includes vehicles and machines of all types, especially wheeled vehicles and tracked vehicles of all types, self-propelled working machines and construction machines, as well as trucks, mobile cranes and the like.

The problem to be solved by the invention is to provide an advantageous power branching transmission.

According to the invention, this problem is solved through the characteristics of Claim 1. The power branching transmission has a mechanical branch (mechanical drive, mechanical branch transmission) and one or more planetary drives. The transmission input shaft of the power branching transmission divides the power, for example, the engine power of the tractor, the working machine, the other vehicle or other machine, into a mechanical branch and a hydrostatic branch. The mechanical power portion and the hydrostatic power portion are then recombined by the planetary drive and output. Instead of a planetary drive, another gear can be used that makes it possible to recombine the mechanical power portion and the hydrostatic power portion.

Advantageous further developments are described in the subsidiary claims.

The mechanical branch includes preferably multiple clutches. It is advantageous if multiple disk clutches are used. The clutches or multiple disk clutches are preferably movable hydraulically. They are preferably disengaged with spring power.

Preferably, the mechanical branch includes multiple shafts. It is advantageous if the mechanical branch includes three shafts which are preferably arranged in a triangle.

A further advantageous development is characterized in that multiple or all shafts of the mechanical branch are provided with two clutches. In this connection, it is advantageous when the first clutches in each case and the second clutches in each case lie in one plane.

If the mechanical branch includes three shafts, preferably arranged in a triangle, which are provided with two clutches, preferably multiple disk clutches, it is advantageous if three clutches in each case lie in a single plane. The first three clutches lie, therefore, in a plane, and the three second clutches also lie in a single plane. The arrangement in which the first and second clutches in each case lie in a plane each is, however, advantageous with more or fewer than three shafts.

According to a further advantageous development, the mechanical branch comprises three shafts, preferably arranged in a triangle, where two shafts with two clutches each, preferably multiple disk clutches, are provided. In this regard, it is advantageous if two clutches in each case lie in a plane. The first two clutches therefore lie in one plane, and the second two clutches also lie in one plane.

Preferably, a clutch in each case can be engaged in a single plane. As a result of the fact that a coupling is engaged or disengaged in a plane, a large number of gear ratios can be obtained in an advantageous manner.

A further advantageous development is characterized in that the ratio of the mechanical part is designed in such a fashion that, at a maximum 40% hydraulic power share of a stage, the next higher stage begins with 100% mechanical power. As a result, the hydraulic power

can be kept low and in a good degree of effectiveness. In certain applications, it may be sufficient for at least one or several ratios of the mechanical part to be arranged in the manner described.

The hydrostatic portion preferably comprises a pump and a motor (hydraulic motor). In this regard, what is preferable is an adjustable pump and/or an adjustable motor. Pump and motor are placed in the closed hydraulic circuit.

According to a further advantageous development, multiple planetary drives are provided. To each planetary drive, a motor (hydraulic motor), preferably an adjustable motor, is assigned. This is especially advantageous if the power branching transmission serves to drive a wheeled or tracked working machine. In this case, on each side of the tracked vehicles that supplies power or on each driven wheel of the wheel-driven working machine, a planetary drive can be provided to supply power. The sun gear of each planetary drive is separately driven in this case by a motor or a hydraulic motor or an adjusting motor. In this manner, the vehicle can be steered through the hydrostatic power portion; the wheel, which receives a greater portion of the hydrostatic power, rotates faster, so that the vehicle performs corresponding curved travel.

It is possible that a single pump, which is preferably an adjusting pump, supplies several or all motors. Preferably, the hydrostatic part, however, has multiple pumps, preferably multiple adjusting pumps. It is advantageous if each motor, and therefore each planetary drive, is assigned a pump. In this case, each individual motor can be fed from its own pump. This brings the advantage that losses due to pressure differences can be avoided.

A further advantageous development is characterized in that the rotational direction of the sun gear of the planetary drives, after the start-up stage up to the highest gear, preferably up to 6th gear,

remains the same. The start-up stage can be 2nd gear, but can also be 3rd or 4th gear. This is especially advantageous if the gear shifting is or becomes automated.

The invention further concerns a tractor or a wheel-driven or track-driven working machine or a commercial truck (a commercial vehicle), which is characterized by a power branching transmission, in accordance with the invention.

Sample embodiments of the invention are explained in detail using the attached drawing. In the drawing, the following are shown:

Fig. 1 a power branching transmission in schematic view and

Fig. 2 a modified embodiment of the power branching transmission.

The power branching transmission shown in Fig. 1 consists of a mechanical branch 1, a hydrostatic branch 2 and a planetary drive 3. The input 4 of the power branching transmission is connected, through a universal joint 5, to the transmission input shaft 6, which splits the input power into a mechanical branch and a hydrostatic branch. The mechanical portion of the power and the hydrostatic portion of the power are then recombined by the planetary drive 3 (instead of the planetary drive, a differential drive could also be used). The planetary drive 3 has a sun gear 7, a planet gear shaft 8 with planet gears and a ring gear 9. Through the planet gear shaft 8, the total of the power of the mechanical branch and the hydrostatic branch is transmitted to the axle distributor gear. This is done through a gear 11 connected to the planet gear shaft 8, which works together with a gear 12 seated on the transmission output shaft 10. The transmission output shaft 10 is connected to the axles through universal joints 13, 14, 15, 16.

The mechanical branch 1 or the mechanical drive consists of three shafts 17, 18; 19, 20 and 21, 22, each with two clutches 2, C; R, B and 1, A. In each case, three clutches lie in one plane. The first three clutches 2, R and 1, which are connected to the input shafts 17, 19 and 21, lie in one plane, namely plane 1. Similarly, the three clutches C, B and A, which are connected to the output shafts 18, 20 and 22, are in one plane, namely plane 2. As shown in the figure in the drawing, the input and output shafts with two clutches each are aligned with each other, namely the input and output shafts 17 and 18 of the clutches 2 and C, the input and output shafts 19 and 20 of the clutches R and B and the input and output shafts 21 and 22 of the clutches 1 and A.

All clutches are multiple disk clutches. Furthermore, all clutches can be actuated under load.

The transmission input shaft 6 is connected to gears 23, 24, 25. The gear 23 works together with the gear 26, which is seated on the input shaft 21. The gear 24 works together with the gear 27, which is seated on input shaft 19. The gear 25 works together with the gear 28, which is seated on input shaft 17.

Gear 29 is seated on output shaft 18. Gears 30 and 31, as well as the ring gear 9 of the planetary drive, are seated on output shaft 20. Gear 32 is seated on output shaft 22.

A clutch housing with a clutch gear 33 belongs to clutches 2 and C. A clutch housing with a clutch gear 34 belongs to clutches R and B. A clutch housing with a clutch gear 35 belongs to clutches 1 and A. The clutch gears 33, 34 and 35 mesh with each other.

The three shafts 17, 18 and 19, 20 and 21, 22 are arranged in a triangle. In operation, one clutch of each level is engaged in order to obtain power flow through to the ring gear 9 of the planetary

drive. Therefore, there is always engaged one clutch of 2, R or 1 in plane 1, as well as one of the clutches C, B or A of plane 2. The clutches, which are multiple disk clutches, are engaged hydraulically and disengaged with spring power.

As shown in the figure in the drawing, the planetary drive is seated on that shaft with which a change in the direction of rotation can be achieved with three different RPM, namely shaft 20. The three rotational speeds with inverted direction of rotation can be used to drive backwards.

The hydrostatic branch 2 or the hydrostatic drive consists of an adjusting pump 36, which can be driven by the transmission input shaft 6, and an adjusting motor (hydraulic motor) 37, which work together in a closed hydraulic circuit 38. The shaft 39 of the sun gear 7 of the planetary drive can be driven by the adjusting motor.

Through the power branching transmission, the ring gear 9 of the planetary drive can be driven mechanically at six rotational speeds in one direction of rotation, and at three rotational speeds in the other direction of rotation. The sun gear 7 of the planetary drive can be driven hydrostatically with continuously variable speed in both directions. A special advantage of the power branching transmission lies in the fact that the power can be transmitted hydrostatically or completely mechanically.

When driving completely hydrostatically, the ring gear 9 of the planetary drive is blocked by engaging two or possibly three clutches on level 2. The power is then transmitted only through the hydraulic branch 2 and the sun gear 7.

If the sun gear 7 of the planetary drive is hydraulically blocked, then a 6/3 step load shifting transmission is obtained.

The mechanical power transmission in branch 1 is set in such a manner that with a maximum 40% hydraulic power portion of one stage, the next higher stage begins with 100% mechanical power. As a result, the hydraulic power can be kept low and at a favorable degree of efficiency.

After the start-up stage, the rotational direction of the sun gear 7 of the planetary drive remains constant up to the 6th gear, which is advantageous if the gear shifting is automated or becomes automated. Figure 2 shows a modified embodiment of a power branching transmission in which those components that agreed with the embodiment of Figure 1 are provided with the same reference symbols, so that they need not be described again. In this embodiment, the power branching transmission consists of a mechanical branch 1, a hydrostatic branch 2 and two planetary drives 41, 42, to each of which an adjusting motor (hydraulic motor) 43 and 44 is assigned. The mechanical branch 1 consists of three shafts 17, 18; 19, 29 and 21, 22 arranged in a triangle, where, however, only on shafts 17, 18 and 21, 22, two clutches 2, B and 1, A are provided in each case. In each case, there are two clutches in a plane and, indeed, clutches 2 and 1, which are connected to the input shafts 17 and 21 (plane 1) and clutches B and A, which are connected to the output shafts 18 and 22 (plane 2). As in the embodiment according to Figure 1, the input and output shafts of each two clutches are aligned with each other, namely the input and output shafts 17 and 18 of the clutches 2 and B and the input and output shafts 21 and 22 of the clutches 1 and A.

The transmission input shaft 6 is connected to gears 23 and 25. The gear 23 works together with the gear 26, which is seated on the input shaft 21. Gear 25 works together with gear 28, which is seated on input shaft 17. Gear 29 is seated on the output shaft 18. Seated on the output shaft 20 are gears 30 and 31, as well as the gear (tapered gear) 45 of an axle distribution drive 46, which meshes with a further gear (tapered gear) 47 of the axle distribution drive 46, which is

seated on a shaft 48. The rotating axles of the gears (tapered gears) 45 and 47 run at right angles to each other.

Gear 32 is seated on the output shaft 22.

A clutch housing with a clutch gear 33 belongs clutches 2 and B. A clutch housing with a clutch gear 35 belongs clutches 1 and A. The clutch gear 33 meshes with a gear 34, which in turn meshes with gear 35.

The shafts 17, 18 and 19, 20 and 21, 22 are arranged in a triangle. In operation, one clutch in each plane is engaged, thus one of the clutches 2 and 1 in level 1 and one of the clutches B and A in level 2.

The hydrostatic branch 2 consists of two adjusting pumps 49, 50, which can be driven by the transmission input shaft 6 and of the two adjusting motors (hydraulic motors) 43 and 44, where the first adjusting pump 49 works together with the first adjusting motor 43 in a closed hydraulic circuit 51, and where the second adjusting pump 50 works together with the second adjusting motor 44 in a second closed hydraulic circuit 52.

The shaft 53 of the sun gear of the first planetary drive 41 can be driven by the first adjusting motor 43. The shaft 54 of the sun gear of the second planetary drive 42 can be driven by the second adjusting motor 44.

At the ends of the shaft 48, gears 55, 56 are provided, each of which meshes with teeth that are provided on the ring gears of planetary drives 41 and 42.

The planet gear shaft 57 of the first planetary drive 41 is connected to a first wheel 58 of a wheel-driven working machine. The planet gear

shaft 59 of the second planetary drive 42 is connected to a second wheel 60 of the wheel-driven working machine. The wheel-driven working machine can be steered by a difference in the adjustment of the adjusting motors 43 and 44.

In the embodiment shown in Figure 1, the power recombination takes place at the output of the mechanical branch and before the axle distribution gearbox. For vehicles or working machines with individually driven wheels and for tracked vehicles with individually driven sides, the embodiment shown in Figure 2 is offered, in which the mechanical branch is brought to the wheels 58, 60 or tracks and in which the power recombination takes place at the end of the drive chain. As can be seen from Figure 2, on each driving side of the tracked vehicle or on each driving wheel, there is a planetary drive 41, 42 to recombine the power. The sun gear of this planetary drive is driven separately by a hydraulic motor 43, 44. As a result, the hydrostatic portion of the power can be used to steer the vehicle. In this connection, a single pump can supply all hydraulic motors or, in order to avoid losses due to pressure differences, each individual motor 43, 44 may be provided with its own pump 49, 50, as represented in Figure 2.

For special applications, when, for example, the main portion of the work is directed in one direction, the number of the mechanical stages can be reduced and placed in the main working direction in order to obtain a high mechanical power portion and a low hydrostatic power portion. Reversing can be done completely hydrostatically by blocking the ring gear. In this case, it is possible to drive completely hydrostatically in both directions of travel.

The embodiment shown in Figure 1 is primarily suitable for tractors, the embodiment according to Figure 2 is primarily suitable for wheel and track-driven working machines.

Patent Claims

1. Power branching transmission, especially for tractors, wheeled and tracked working machines and commercial machines, with
a mechanical branch (1),
a hydrostatic branch (2)
and one or more planetary drives (3; 41, 42).

2. Power branching transmission in accordance with Claim 1, characterized in that, the mechanical branch (1) contains multiple clutches (2, C; R, B; 1, A or 2, B; 1, A), preferably multiple disk clutches.

3. Power branching transmission in accordance with Claim 1 or 2, characterized in that, the mechanical branch (1) has multiple shafts (17, 18; 19, 20; 21, 22), preferably three shafts, which are preferably arranged in a triangle.

4. Power branching transmission in accordance with one of the foregoing Claims, characterized in that, several or all shafts (17, 18; 19, 20; 21, 22), of the mechanical branch (1) are provided with two clutches each (2, C; R, B; 1, A or 2, B; 1, A).

5. Power branching transmission in accordance with Claim 4, characterized in that, the first clutches in each case (2, R, 1; 2, 1) and the second clutches in each case (C, B, A; B, A) are each placed in one plane (plane 1, plane 2).

6. Power branching transmission in accordance with one of the foregoing Claims, characterized in that, the mechanical branch (1) includes three shafts (17, 18; 19, 20; 21, 22), preferably arranged in a triangle, which are provided with two clutches each (2, C; R, B; 1, A), preferably multiple disk clutches,

where preferably three clutches in each case (2, R, 1; C, B, A) lie in a single plane (plane 1; plane 2).

7. Power branching transmission in accordance with one of the Claims 1 through 5, characterized in that, the mechanical branch (1) includes three shafts (17, 18; 19, 20; 21, 22), preferably arranged in a triangle, where two shafts (17, 18; 21, 22) are provided with two clutches each (2, B; 1, A), preferably multiple disk clutches, where preferably two clutches in each case (2, 1; B, A) lie in a single plane (plane 1; plane 2).

8. Power branching transmission in accordance with one of the Claims 5 through 7, characterized in that, in each case a clutch (2, R, 1; C, B, A or 2, 1; B, A) in a plane (plane 1; plane 2) can be engaged.

9. Power branching transmission in accordance with one of the foregoing Claims, characterized in that, the gear ratios of the mechanical part (1) are designed in such a fashion that, by at most 40% hydraulic power portion of one gear, the next higher gear begins with 100% mechanical power.

10. Power branching transmission in accordance with one of the foregoing Claims, characterized in that, the hydrostatic part (2) contains one or more pumps (36; 49, 50), preferably adjusting pumps, and one or more motors (37; 43, 44), preferably adjusting motors.

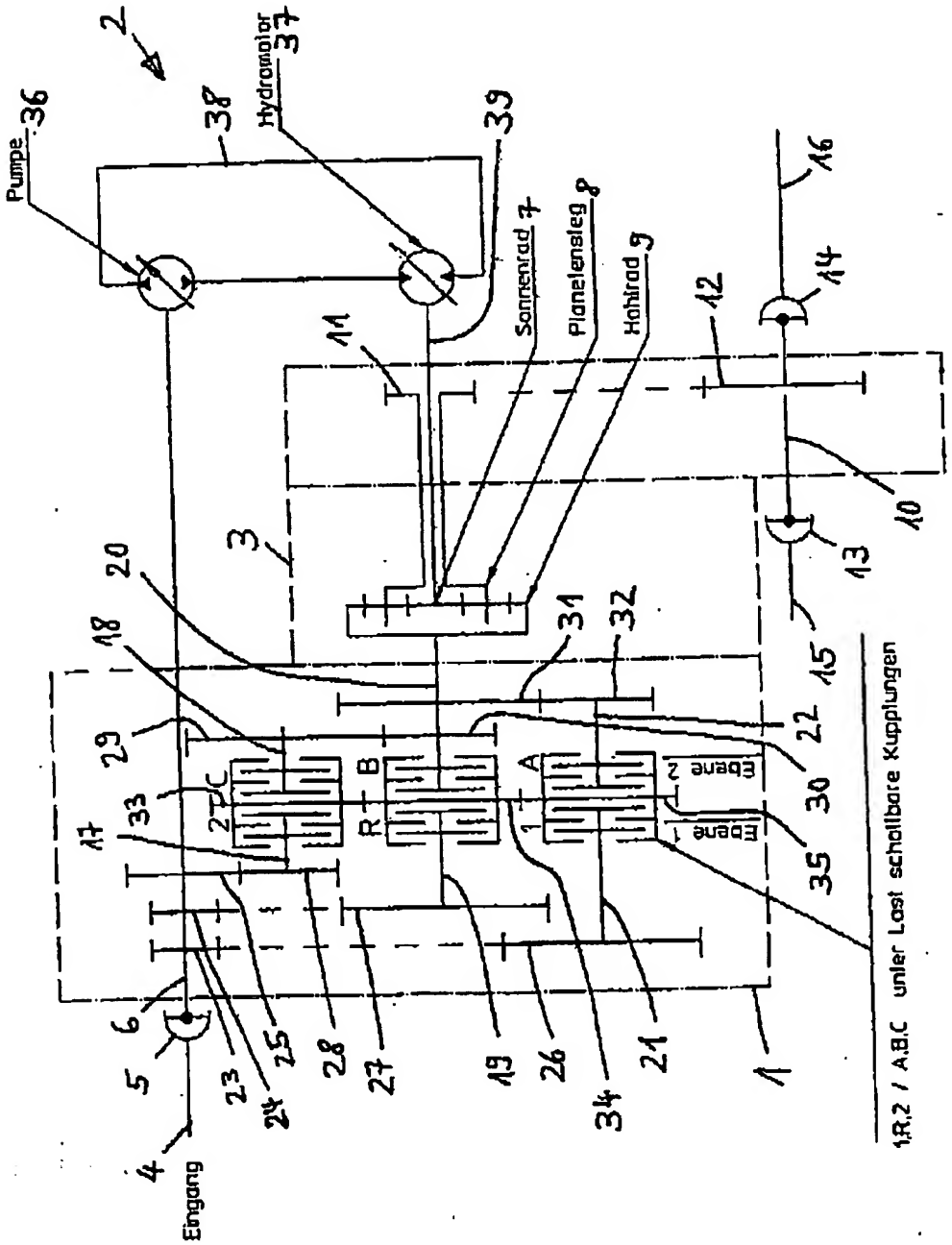
11. Power branching transmission in accordance with one of the foregoing Claims, characterized in that, several planetary drives (41, 42) are provided.

12. Power branching transmission in accordance with one of the foregoing Claims, characterized in that, the hydrostatic part

(2) contains multiple pumps (49, 50), preferably adjusting pumps.

13. Power branching transmission in accordance with one of the foregoing Claims, characterized in that, the rotational direction of the sun gear (7) of the planetary drive (3), after the start-up stage and up to the highest gear, preferably 6th gear, remains the same.

14. Tractor or wheeled or tracked working machine or commercial vehicle, characterized by a power branching transmission according to one of the foregoing claims.

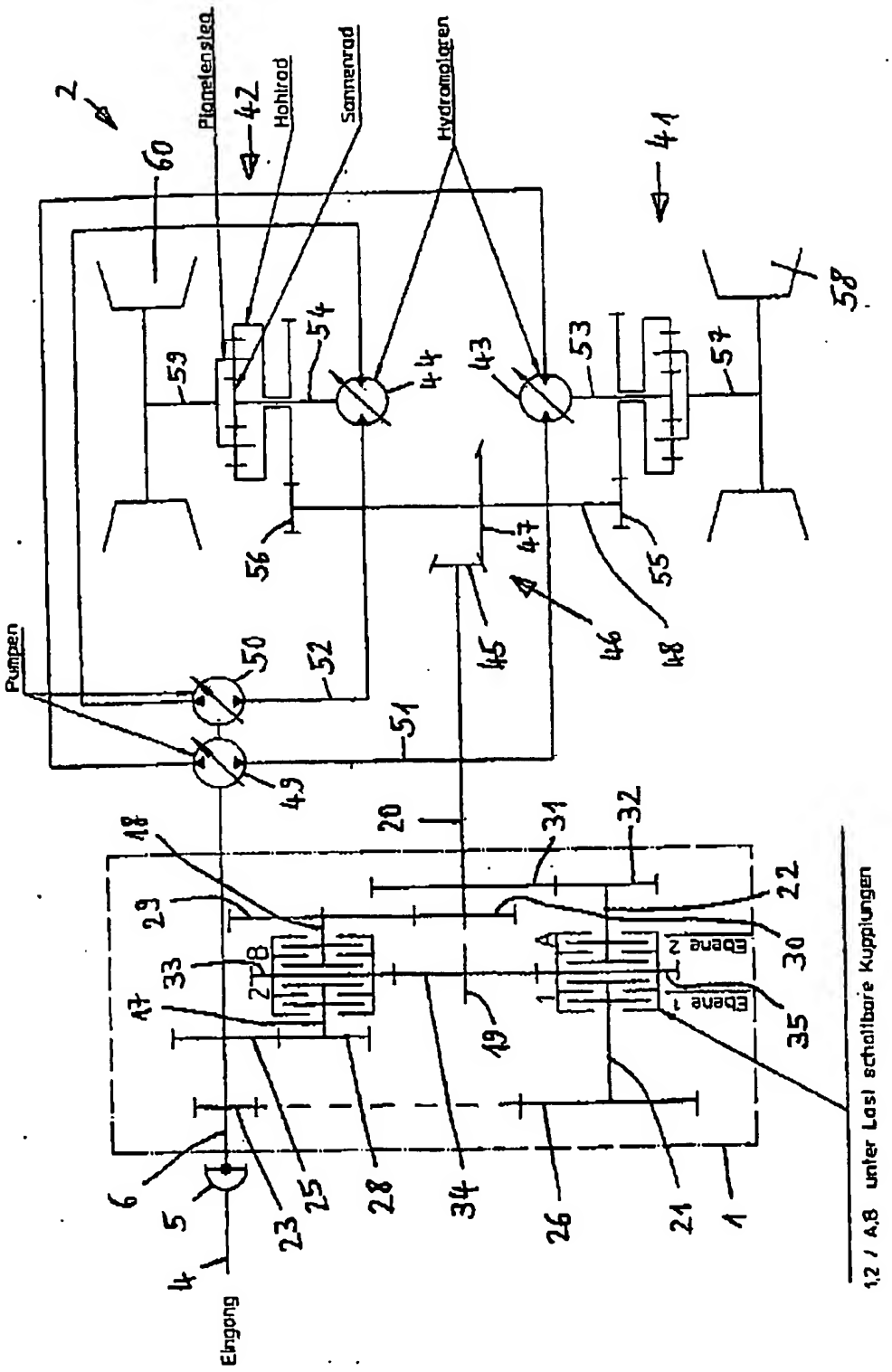


Schema 1

Fig-1

CA 02383121 2001-11-21

WO 00/71377 PCT/EP00/04538



Schema 2

Fig. 2